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A REVIEW ON FOLIAR SCLEREIDS IN ANGIOSPERMS

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ABSTRACT

A review based on the data on foliar sclereids retrieved from earlier as well as recent publications has been prepared. An analysis of the account indicates that about 430 genera belonging to 110 families spread over 47 orders have foliar sclereids. The majority of taxa exhibit diffuse pattern of distribution of sclereids and terminal pattern has been recorded in 45 genera belonging to 25 families. Their morphogenic importance is also referred.

INTRODUCTION

The adaptive, systematic or phylogenetic value of the sclereids has been a subject of much consideration and speculation in the past. Before attempting any broad-based conclusions relating to the morphological trends of specialisation and the topographical variations of sclereids, it may be useful to review the literature.

In this review Hutchinson's classification (1959) is adopted. Further changes in the ordinal placement of the families as well as the newly erected families as given in Hutchinson's (1969) and Takhtajan's (1966) works have been incorporated in this account. While preparing this review, the data on foliar sclereids have been mostly retrieved from the earlier works of Solereder (1908, here abbreviated Sol.) and Metcalfe and Chalk (1957, here abbreviated, M.C.) and from many recent publications of several authors referred to in the synoptic review. The type of sclereids not followed by references are the author's own observations. It is clear that many of the citations from Sol. and M. C. need to be examined afresh for a clearer picture of the sclereid typology and their pattern of distribution.

The objective of this review is threefold:

1. to review the literature past and present;
2. to recognise the sclereid-bearing genera and record the typology of sclereids and their patterns of distribution;
3. to decide whether their occurrence reflect any morphogenic trend or otherwise.

SYNOPSIS OR REPORTED RECORDS OF FOLIAR SCLEREIDS IN ANGIOSPERMS

Magnoliales

Magnoliaceae: *Aromadendron, Kmeria, Manglietia, Michelia,* (Terminal sclereids; Tucker 1964)—Winteraceae: *Bubbia, Zygogynum* (Diffuse sclereocysts; Bailey and Nast 1944a, b; Vink 1977)—Canellaceae: *Canella, Cinnamosma, Pleodendron, Warburgia* (Terminal sclereids; Parmeswaran 1961)—Himatandraceae: *Himatandra* (Sclerocysts; Bailey *et al.* 1943)—Eupteleaceae (in Trochodendraceae, Hutchinson 1969): *Euptelea* (Sol. p. 32; M.C. p. 34-36)—Trochodendraceae: *Trochodendron* (Diffuse polyramous sclereids; Foster 1945a, b)—Annonaceae: *Anaxagorea, Annona, Asteranthe, Habzelia, Heteropetalum, Sageretia, Unona* (Sol. p. 36; M.C. p. 45); *Goniothalamus* (Diffuse fusiform or ramiform sclereids; Bluden *et al.* 1973); *Cyatho-*

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calyx, Desmos, Phaeanthus (Diffuse filiform sclereids; Rao and Wee 1966); *Popowia* (Mixed pattern of ramiform or I. shaped sclereids; Rao and Wee 1966); *Uvaria* (Idiofibrosclereids; Rao 1951a; Rao and Bhupal 1971, 1973).

Dilleniales

Dilleniaceae: *Hibbertia* (Terminal and Mixed pattern; spheroidal to polyramous sclereids; Dickison 1969, 1970; Rao and Silpi Das 1979); *Tetracera, Wormia* (Sol. p. 21-22; M.C. p. 10)—Connaraceae: *Rourea* (Sol. p. 251; M.C. p. 473); *Pseudoconnarus* (Terminal astrosclereids; Dickison 1973; Schellenberg 1938).

Berberidales

Menispermaceae: *Abuta, Adeliopsis, Albertisia, Anomospermum, Chlaenandra, Chondrodendron, Coscinium, Detandra, Husemannia* (Sol. p. 40; M.C. p. 53); *Rhaptonema, Stephania* (Idiofibrosclereids; Kundu and Guha 1976); *Anamirta, Arcangelisia* (Idiofibrosclereids; Wilkinson 1978); *Burassia, Limacia, Parabaena, Penianthus* (*Heptacyclum*). (Diffuse polyramous sclereids).

Ranales

Nymphaeaceae: *Barclaya, Euryale, Nuphar, Nymphaea, Victoria* (Diffuse Rhizoform, fusiform, ramiform and polyramous sclereids; Rao and Banerjee 1979; Conard 1905; Gaudet 1960; Malaviya 1962; Sol. p. 48; M.C. p. 69).

Cappardiales

Capparaceae: *Capparis* (Diffuse and Terminal sclereids; Rao and Mody 1961, Rao and Silpi Das 1978, Bokhari and Hedge 1976); *Boscia* (Diffuse dendrosclereids; Pestalozzi 1898); *Niebuhria* (Terminal polyramous sclereids; Rao and Kelkar 1951, Rao 1958); *Cadaba, Courbonia, Thylachium* (Sol. p. 67-70; M.C. p. 90).

Bixales

Flacourtiaceae: *Calantica, Casearia, Erythrospermum, Homalium, Patrisia, Ryania* (Sol. p. 88; M.C. p. 117).

Polygaleales

Polygalaceae: *Moutabea* (Terminal polymorphic sclereids; Foster 1947, Styer 1978). *Asteropeia* (Diffuse polymorphic sclereids); *Polygala, Monnina, Badiera* (Sol. p. 96; M. C. p. 118, 127)—Vochysiaceae: *Vochysia* (Terminal and mixed pattern of polyramous sclereids and macrotracheoids; Rao and Mody 1961); *Lightia, Trigoniastrum* (Sol. p. 102; M. C. p. 140).

Tamaricales

Tamaricaceae: *Reaumuria* (Terminal polyramous sclereids). *Hololachne* (Sol. p. 114; M. C. p. 156)—Frankeniaceae: *Frankenia* (Sol. p. 105).

Theales

Theaceae: *Eurya* (Diffuse polyramous sclereids; Francken 1890). *Freziera* (Diffuse polyramous sclereids; Pekelharing 1908). *Laplacea* (Diffuse polyramous sclereids; Cavara 1897). *Nabiasodendron, Pyrenaria, Visnea* (Diffuse polyramous sclereids; Besuvisage 1920). *Adinandra, Anneslea, Cleyera, Franklinia* (Diffuse polymorphic sclereids; Sol. p. 128-129; M.C. p. 183-184)—Camelliaceae: *Camellia* (Diffuse polyramous sclereids; Foster 1944, Barua and Wight 1959, Barua and Dutta 1960, Keng 1962, Foard 1958, 1959; Foard and Lewis 1961)—Ternstroemiaceae: *Gordonia, Schima, Ternstroemia* (Diffuse polyramous sclereids; Pseudoterminal sclereids; Giant sclereids; Rao 1951a, 1952; Besuvisage 1920)—Bonnetiaceae: *Bonnetia* (Diffuuse sclereids; Keng 1962; M. C. p. 194)—Tetrameristaceae: *Tetramerista* (Sol. p. 189; M.C. p. 339)—Caryocaraceae: *Anthodiscus, Caryocar* (M.C. p. 196)—Marcgraviaceae: *Marcgravia, Norantea, Ruyschia, Souroubea* (Diffuse polymorphic sclereids; Richter 1899, 1920; De Roon 1967)—Pelliciceraceae: *Pelliciera* (Diffuse librosclereids; Besuvisage 1920).

Malvales

Malvaceae: *Goethea, Pavonia* (Sol. p. 147; M.C. p. 226).

TILIALES

Bombacaceae: *Bombax, Ceiba* (Sol. p. 148; M.C. p. 226)—Scytopetalaceae: *Brazzeia, Rhaptopetalum, Scytopetalum* (Sol. p. 846; M.C. p. 267)

MALPIGHIALES

Linaceae: *Hugonia, Ochthocosmus* (Sol. p. 159; M.C. p. 269)—Erythroxylaceae: *Erythroxylum* (Diffuse polymorphic sclereids; Pereira Dos Sentos 1974)—Humariaceae: *Sacoglottis* (Sol. p. 849; M.C. p. 278)—Zygophyllaceae: *Nitraria* (Sol. p. 850; M.C. p. 287).

RUTALES

Rutaceae: *Boronia* (Terminal polymorphic sclereids; Schulze 1902, Foster 1955b, Rao and Bhattacharya 1978). *Boronella* (Terminal polymorphic sclereids; Foster 1955a)—Simaroubaceae: *Eurycoma, Hyptiandra* (Diffuse filiform sclereids), *Quassia, Simaba, Simarouba, Simaroubopsis* (Diffuse polymorphic sclereids), *Irivingella, Irvingia, Picramnia, Picrasma* (Idiofibrosclereids), *Mannia, Odyendea, Samadera* (Sol. p. 859, M.C. p. 319).

OCHNALES

Ochnaceae: *Ochna* (Idiofibrosclereids, Rao 1951a), *Blastemanthus, Cespedesia, Elvasia, Hilariella, Luxemburgia, Poecilandra, Trichovaselia, Vaselia* (Sol. p. 867; M.C. p. 335).

MELIALES

Meliaceae: *Dasoxylum, Khaya* (Diffuse polymorphic sclereids).

OLACALES

Olacaceae: *Heisteria, Olax* (Diffuse ramiform sclereids and also contrasted form of idioblasts; Rao and Mody 1961), *Scorodocarpus* (Diffuse polymorphic sclereids; Rao 1975), *Ptychopetalum* (Terminal sclereids; Foster 1947), *Eganthus, Endusa, Ochanostachys, Phlebocalymna, Schoepfia, Ximenia* (Sol. p. 871; M. C. p. 895).

Opiliaceae: *Agonandra, Cansjera, Lepionurus, Opilia* (M.C. p. 379).

CELASTRALES

Icacinaceae: *Stemonurus* (Diffuse astrosclereids; van Stavern and Baas 1973), *Desmostachys, Discophora* (M.C. p. 369)-Aquifoliaceae: *Ilex* (Diffuse fusiform sclereids; Baas 1975)—Salvadoraceae: *Azima, Dobera, Salvadora* (Diffuse sclereids-infrequent; Rao 1951a, 1957a; agglomerate sclereids or tracheoids; Govindarajalu and Parmaswaran 1965, Rao and Silpi Das 1979b)—Celastraceae: *Kokoona, Lophopetalum, Maurocenia* (Diffuse spheroidal or sub-spheroidal sclereids; Jansen and Baas 1973), *Microtropis* (Diffuse spheroidal sclereids; Rao 1976), Maytenus (Idiofibrosclereids), *Schæfferia* (Sol. p. 877; M. C. p. 390). Goupiaceae: *Goupia* (Terminal vesiculose sclereids; Rao and Bhattacharya 1975)—Hippocrateaceae: *Salacia* (Idiofibrosclereids).

RHAMNALES

Rhamnaceae: *Caenothus, Microrhamnus* (*Condalia*), *Rhamnus, Sarcomphalus* (Sol. p. 886; M.C. p. 405).

SAPINDALES

Sapindaceae: *Cupaniopsis, Haplocoelum, Matayba, Paullinia, Serijania, Xerospermum* (Sol. p. 229; M.C. p. 421)—Hippocastanaceae: *Billia* (Sol. p. 236; M.C. p. 439)—Anacardiaceae: *Bouea* (Diffuse polymorphic sclereids).

ROSALES

Mimosae: *Affonsea, Calliandra, Inga, Parkia, Pithecolobium, Prosopis, Piptadenia, Stryphnodendron* (Sol. p. 292, 294; M.C. p. 480)—Caesalpineae: *Heterostemon, Macrolobium, Saraca, Schotia* (Sol. p. 284; M.C. p. 491), *Cynometra* (Terminal sclereids; Rao and Bhupal 1972b), *Cassia* (Terminal vesiculose sclereids; Banerjee and Sirkar 1974), *Dimorphandra, Mora* (Terminal and also diffuse sclereids of vesiculose type; Ragonese 1973), *Oxystigma* (Sol. p. 904)—Fabaceae: *Ormosia* (Terminal vesiculose sclereids), *Ammodendron, Andira, Bossiaea, Bowdichia, Dillwynia, Platymiscium, Pultenaea, Swartzia, Buchenroedera* (Sol. p. 258; M.C.

p. 509)—Kramariaceae: *Krameria* (Terminal sclerotracheoids; Rao and Silpi Das 1979b)—Rosaceae: *Couepia, Lecostemon, Licania* (Sol. p. 302; M.C. p. 551)—Cunoniaceae: *Cunonia, Weinmannia* (Terminal sclereids; Dickison 1975), *Pancheria* (M.C. p. 560)—Oliniaceae: *Olinia* (Terminal sclereids; Mujica and Cutter 1974)—Hamamelidaceae: *Rhodoleia* (Terminal polymorphic sclereids; Bhupal and Kundu 1969; Rao 1973), *Eustigma, Exbucklandia, Disanthus, Distylium, Loropetalum, Sycopsis* (Terminal sclereids; Idiofibrosclereids; Rao and Bhupal 1974a; Reinch 1890)—Bruniaceae: *Linconia, Lonchostoma* (Sol. p. 334; M.C. p. 595).

MYRTALES

Rhizophoraceae: *Rhizophora* (Diffuse polymorphic sclereids; Rao *et al.* 1978), *Bruguiera* (Terminal contrasted form of cells; Rao and Sharma 1968), *Ceriops, Kandelia* (Terminal sclereids and tracheoids), *Poga* (Sol. p. 340, 917; M.C. p. 603)—Combretaceae: *Anogeissus, Combretum, Ramatuella, Thiola* (Sol. p. 344)—Myrtaceae: *Angophora, Eucalyptus* (Idiofibrosclereids; Carr *et al.* 1971), *Eugenia, Jambosa, Asteranthos* (Sol. p. 352, 356; M.C. p. 621)—Melastomataceae: *Coryphadenia* (Terminal sclereids; Morley 1953a, b), *Gravesia* (Diffuse sclereids; de Cordemony 1914), *Memecylon* (Terminal monomorphic and polymorphic sclereids; Rao 1957a, 1950b, Rao and Dakshni 1963, Rao and Bhupal 1974b, Subramanyam and Rao 1949, Rao and Jacques-Felix 1978), *Mouriri* (Terminal monomorphic and polymorphic sclereids; Foster 1946, 1947, Morley 1953a), *Plethiandra* (Diffuse sclerocysts and polymorphic sclereids; Rao and Bhattacharya, 1977), *Henriettella, Huberia, Lavoisiera, Leandra, Medinilla, Miconia, Microticia* (Sol. p. 923; M.C. p. 641)—Crypteroniaceae: *Alzatea, Crypteronia, Dactylocladus, Rhynocalyx* (Diffuse sclereids; van Vliet and Baas 1975)—Sonneratiaceae: *Sonneratia* (Diffuse polymorphic sclereids; Banerjee and Rao 1975).

PASSIFLORALES

Turneraceae: *Turnera* (M.C. p. 671)—Passifloraceae: *Passiflora* (Sol. p. 384; M.C. p. 675).

CUCURBITALES

Begoniaceae: *Begonia* (Diffuse septate spheroidal sclereids, Gertz 1951, Costa 1971)—Datiscaceae: *Octomeles* (Diffuse polymorphic sclereids), *Tetrameles* (Diffuse costal sclereids; Davidson, 1973).

ARALIALES

Cornaceae: *Griselinia, Mastixia* (Diffuse sclereids)—Alangiaceae: *Alangium* (Diffuse sclereids; Govindarajalu 1962; Idiofibrosclereids)—Garryaceae: *Garrya* (Diffuse Gnarlyform and polymorphic sclereids; Paliwal and Kakkar 1970)—Nyssaceae: *Nyssa* (Diffuse sclereids; Mody 1958)—Caprifoliaceae: *Viburnum* (M.C. p. 753).

RUBIALES

Rubiaceae: *Jovetia* (Foliar hair sclereid, Guedes 1975), *Scyphiphora* (Terminal polymorphic sclereids; Rao and Wan 1969), *Burchellia, Chomalia, Coffea* (Sol. p. 446; M.C. p. 761).

CAMPANALES

Goodeniaceae: *Dampiera, Scaevola* (Terminal and diffuse sclereids; Rao and Mody 1961).

ERICALES

Epacridaceae: *Andersonia* (Contrasted form of idioblasts)—Ericaceae: Craibiodendron (Terminal spheroidal cell), *Diplycosia, Erica, Gaultheria, Pernettya, Rhododendron, Leucothoe* (Sol. p. 483; Hayes *et al.* 1951; M.C. p. 830).

PRIMULALES

Plumbaginaceae: *Aegialitis* (Diffuse polyramous sclereids; Abraham 1965), *Limonium* (Terminal, Sclerocyst and mixed pattern of polymorphic sclereids; Rao and Das 1968, Bokhari 1970), *Limoniastrum, Goniolimon* (Diffuse sclereids)—Primulaceae: *Dionysia* (Terminal, and diffuse sclereids; Bokhari and Wendelbo 1976)—Myrsinaceae: *Aegiceras* (Diffuse polymorphic sclereids;

Rao 1971), *Theophrasta* (Sol. p. 507 ; M.C. p. 865).

EBENALES

Sapotaceae: *Manilkara* (Idiofibrosclereids ; Rao 1951a, 1960), *Chrysophyllum* (Diffuse filiform sclereids), *Amorphospermum, Bumelia, Labourdounaisia, Madhuca, Mimusops, Pouteria, Sideroxylon* (Sol. p. 513 ; M.C. p. 873)—Ebenaceae: *Diospyros* (Diffuse and pseudoterminal sclereids, Rao 1951b), *Maba* (Marginal strand composed of sclereids ; Rao and Kelkar 1950), *Euclea* (Sol. p. 517 ; M.C. p. 881)—Symplocaceae: *Symplocos* (M.C. p. 891).

GENTIANALES

Oleaceae: *Jasminum* (Costal sclereids; Govindarajalu and Karunakaran 1978), *Nyctanthes* (Diffuse palosclereids in the vicinity of midrib ; Rao 1947, 1953, Khan *et al.* 1976), *Linociera, Ligustrum, Olea, Osmanthus* (Diffuse monomorphic and polymorphic sclereids ; Arjee 1953a, b ; Rao 1948, 1950a, 1957b, 1949, 1953 ; Rao and Manna 1975, Griffith 1968, Green 1958), *Schrebera* (Terminal vesiculose sclereids ; Rao 1949, 1951a), *Haenianthus* (Diffuse Rhizo- and Palosclereids ; Howard 1960), *Notelaea, Noronhia* (Sol. p. 522 ; M.C. p. 895)—Apocynaceae: *Aspidosperma, Bousigonia, Michrechites, Neocouma, Trachelospermum, Sclerodictyon* (Sol. p. 529 ; M.C. p. 907)—Asclepiadaceae: *Dischidia* (Diffuse filiform sclereids)—Loganiaceae: *Fagraea* (Diffuse polymorphic sclereids ; Rao 1951a, 1965, Singh 1967), *Anthocleista, Strychnos* (Sol. p. 540 ; M.C. p. 927) —Gentianaceae: *Nymphoides* (Diffuse polymorphic sclereids ; Malaviya 1963), *Limnanthemum, Liparophyllum, Villarsia* (Sol. p. 548 ; M.C. p. 937).

POLEMONIALES

Boraginaceae: *Cordia* (Sol. p. 555 ; M.C. p. 948)—Convolvulaceae: *Dicranostyles, Eryciba, Humbertia, Lysiostyles, Maripa, Prevostea* (Sol. p. 564 ; M.C. p. 957), *Ipomoea* (Foliar stomatal guard cells sclerosed ; Inamdar and Patel 1971)—Orobanchaceae: *Kopsiopsis* (M.C. p. 989)—Gesneriaceae: *Cyrtandra* (Diffuse polymorphic sclereids ; Bokhari and Burtt 1970, Burtt and Bokhari 1973), *Stauranthera* (M. C. p. 997), *Hemiboea* (Solereder 1912)—Bignoniaceae: *Coba, Crescentia Phyllarthron* (Brachysclereids ; Sol. p. 602 ; M. C. p. 1004)—Scrophulariaceae: *Dopatrium, Lindernia, Torenia* (Diffuse brachysclereids ; Verghese 1969)—Acanthaceae: *Elytraria, Staurogyne* (Diffuse astrosclereids and also pseudoterminal sclereids ; Enayet Hossain 1974).

LAMIALES

Globulariaceae: *Globularia* (Sol. p. 628 ; M. C. p. 1039)— Verbenaceae: *Citharexylum, Petrea* (M. C. p. 1032)—Myrsticaceae: *Gymnacranthera, Horsfieldia, Knema* (Diffuse monomorphic and polymorphic sclereids ; Rao and Wee, 1966), *Iryanthera* (Diffuse polymorphic sclereids).

LAURALES

Lauraceae: *Actinodaphne, Cinnamomum* (in petiole only), *Ocotea, Persea, Ravensara* (Sol. p. 703 ; M. C. p. 1146).

PROTEALES

Proteaceae: *Adenanthos, Isopogon, Petrophile,* (Gnarlyform sclereids), *Bellendena,* (*Terminal sclereids*), *Leucospermum* (Diffuse gnarlyform, spheroidal to polymorphic sclereids ; Rao and Silpi Das 1976 ; Rao 1950b ; Jonsson 1880), *Banksia, Dobarea, Dryandra, Grevillea, Leucospermum, Paranomus, Protea, Roupala, Sorocephalus, Stenocarpus, Xylomelum* (Sol. p. 710 ; M.C. p. 1162) *Hakea,* (Heide—Jorgensen 1978).

THYMELEALES

Thymelaeaceae: *Enckleia, Linostoma* (Terminal polymorphic sclereids ; Neveling 1961a, b ; Rao and Bhupal 1972), *Daphne, Daphnopsis, Cyrinops, Lasiosiphon, Stephanodaphne* (Sol. p. 716 ; M. C. p. 1170)—Penaeaceae: *Glischrocolla, Saltera, Stylapterus, Brachysiphon* (Diffuse filiform sclereids ; Dahlgren 1968), *Penaea, Saracocolla* (Diffuse filiform sclereids ; Rao 1965, Rao and Silpi Das 1976b, Dahlgren 1971, 1978), *Endonema* (Sol. p. 722; M. C. p. 1182).

SANTALALES

Loranthaceae: *Loranthus* (Diffuse polyramous sclereids; Rao and Kelkar 1951), *Dendropthae* (Diffuse polyramous sclereids; Rao and Malaviya 1962), *Oryctanthus* (Sclereid sheaths with crystals; Kuijit 1961), *Phoradendron, Stachyphyllum, Viscum, Nuytsia* (Sol. p. 727; M. C. p. 1198)—Santalaceae: *Acanthosyris, Buckleya, Jodina. Osyris, Quinchamalium, Thesium* (Silicified Sol. p. 732; M.C. p. 1196)—Euphorbiaceae: *Tragia* (Diffuse macrosclereids; Rao and Rao, 1975), *Phyllanthus* (Idiofibrosclereids; Webster 1965), *Acalypha, Actephila, Actinostemon, Alchornea, Amanoa, Bernardia, Chaetocarpus, Chondrostylis, Conceveiba, Dalechampia, Erismanthus, Euphorbia, Givotia, Mabea, Pausandra, Sebastiania, Trigonostemon* (Sol. p. 744; M.C. p. 1213).

URTICALES

Moraceae: *Balanostreblus* (Diffuse filiform sclereids), *Ficus, Sahagunia, Stillingia* (De Wolfe 1969, Sol. p. 770; M. C. p. 1262).

CHENOPODIALES

Chenopodiaceae: *Arthrocnemum* (Fahn 1969).

MONOCOTYLEDONS:

PALMALES

Arecaceae: *Bactris, Eugeissona, Daemonorops, Licula, Lodoicea* (Diffuse fibriform, columner; fiber-like sclereids, Tomlinson 1959).

ARALES

Araceae: *Monstera, Rhaphidophora, Scindaspus* (Diffuse Trichosclereids; van Tieghem 1866, Francken 1890, Bloch 1946, Rao 1954, 1964, 1977, Singh 1968, Nicolson 1960).

AGAVALES

Agavaceae: *Agave* (Marginal and terminal foliar spines with sclereids; Bluden 1973).

JUNCALES

Thurniaceae: *Thurina* (Sclereids at sub-stomatal boarder; Cutler 1969)—Restionaceae: *Anarthria, Ecdeiocolea* (Osteosclereids and elongated sclereids around sub-stomatal cavities; Cutler 1969)—Dicot with doubtful position. Emblingiaceae: *Emblingia* (Branching sclereids; Metcalfe 1969).

CONCLUSIONS

An analysis of the aforesaid table indicates that about 430 genera belonging to 110 families spread over 47 orders display foliar sclereids. Among them, it is clear that the occurrence of terminal sclereids at the ordinal, familial or generic level is not widespread. It should, however, be remembered that the detailed morphological studies have been made, even on a generous estimate, in less than 1000 species belonging to 25 to 30 families. From this study it appears that the majority of members exhibit diffuse pattern of sclereids and the terminal pattern has been recorded only in 45 genera belonging to 25 families. The latter feature is confirmed by ontogeneic studies in *Mouriri* (Foster, 1947), *Memecylon* (Rao, 1951, 1957a, *Boronia* Foster, 1955b) and *Niebuhria* (Rao 1958). The occurrence of sclereid initials near the differentiating procambial strand and their further development clearly indicate the possibility of considering this feature as an inherited character deeply anchored in the genotype. This view seems to be confirmed by repeated findings of sclereids in a species growing in different habitats. This situation is intrigueing and whether it is an adaptation selected in the course of evolution as a response to any particular environmental stress needs further proof.

MORPHOGENIC TRENDS:

Not enough research has been done in this regard but a few points bearing on this aspect are briefly referred to here. Recent work has shown that the co-occurrence of contrasted forms of terminal idioblasts mostly in the form of tracheoids, sclereids and hybrid cells at the veinlet endings in the leaves of *Mouriri* (Foster, 1946) and *Memecylon* (Rao, 1957a; Rao and Jacques-Felix 1978) of the Melastomataceae, *Aromadendrum, Kmeria, Manglietia, Michelia* of the Megnoliaceae (Tucker, 1964), *Hibbertia* of the Dilleniaceae (Dickison, 1969), *Salicornia* of the Chenopodiaceae (De Fraine, 1912), *Boronia* of the Rutaceae (Foster, 1955b), *Euphorbia* of the Euphorbiaceae (Pirwitz, 1931), *Bruguiera* of the Rhizophoraceae (Rao and Sharma, 1968), *Olax* of the Olacaceae (Rao and Mody, 1961), *Scaevola* of the Goodeniaceae (Rao and Mody, 1961) and *Vochysia* of the Vochysiaceae (Rao and Mody, 1961) and a few taxa of Connaraceae (Dickison, 1973) merit some attention. It is attractive to speculate that terminal sclereids have evolved from terminal tracheoids. The several cases on record as referred to above amply illustrate and substantiate this speculation. Foster (1947) indicates, however, that even if a complete transitional trend in structural specialisation from tracheoid to the sclereid could be demonstrated, a phylogenetic connection is not proved. The above findings in closely and also in widely separated members belonging to different orders or families can be considered as a significant morphological aspect occurring independently at various levels in the phylogenetic classification. Similarly, terminal sclereids well represented in different and distant families can hardly suppose to have a common phylogenetic origin. Thus their polyphyletic origin which, though not conclusive in itself, may be significant when combined with other data which on the basis of other criteria, is considered rather primitive (Dickison, 1969).

Further, the differentiation of veinlet endings from conventional tracheids to varied idioblasts in the leaves of several taxa 'that belong to diversified taxonomic and ecological group makes it difficult to understand their evolutionary and functional significance' (Fahn 1969, p. 100). Furthermore, it is seen that not only closely related families but also in different species of the same genus, sclereids differ from each other and some species possess them while some do not as illustrated in the present study on several taxa. Whether this should be attributed to special condition of life or a part of a syndrome connected with ecological adaptation, we have no answar.

Another suggestion as put forward by Francken (1890) is that the phylogenetic origin of sclereids should not be ascribed to physiological circumstances. Rao (1953) is of the opinion that it can hardly be otherwise. In support of his statement, the absence or presence of sclereids in xeric and hydric leaves can be cited. Similarly the abundance and scarcity of the veinlet elements in the same species collected from different regions does cast doubt on the importance of veinlet elements to normal physiological activity in the leaf (Lersten and Carvey, 1974). It is possible, however, that the factors which are responsible for the origin of sclereids whether physiological or genetical can be solved only by experimental study (Foster, 1947; Rao and Bhupal, 1972b). The reported occurrence of only hybrid cells in the lamina of *Mouriri* and another specimen of the same species possessing only terminal sclereids make it plain that the question of ontogeneic and phylogeneic relationship between tracheary elements and sclereids requires intensive as well as extensive study (Foster, 1946).

While working on terminal sclereids and tracheoid idioblasts, Rao and Mody (1961) observed that any genus which has well developed terminal tracheoid idioblasts will have some species or all species with well developed terminal sclereids. They cite clear illustrations from the works of Foster (1946, 1955) on *Mouriri* and *Boronella*, Rao (1957a. b, 1958, 1961) on *Memecylon* and *Niebhuria* and Rao and Mody (1961) on *Capparis, Scaevola* and *Vochysia*. The same view-point holds good in case of *Boronia* also (Rao and Bhattacharya, 1978b). As a contrast, in *Boronella pancheri* and *B. francii* only diffuse sclereids and lobed tracheoid like cells at the veinlet endings have been recorded (Foster, 1955). These are the interesting examples of topographic fluctuations and show the need for intensive as well as cautious approach in obtaining information on morphogenic aspects of terminal vein-endings.

In conclusion, it might be said that sclereids and their definite topographical position as well as fluctuations pose many problems which are as yet unsolved. Whether they have any adaptive or proved biological significance is as yet not proved. Have they arisen in response to some biological need or are they in least part fortuitous and independent of function, are questions which are baffling. The most vital question regarding sclereids is: Why do plants possess sclereids? Or, in other words, what selective advantage does the presence of sclereids confer? According to many workers the occurrence of sclereids is helpful for mechanical function. There are evidence in many plants to show that this is a valid argument (Rao, 1957b). There are not sufficient evidences to support the idea of Francken (1890) that they are rudiments which have lost their original value for the living plant. Till the real situation is known, it can safely be regarded as an instance of a truly fortutious anatomical character. Any solution, however, to these riddles lies in future experimental and comparative ecological observations.

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